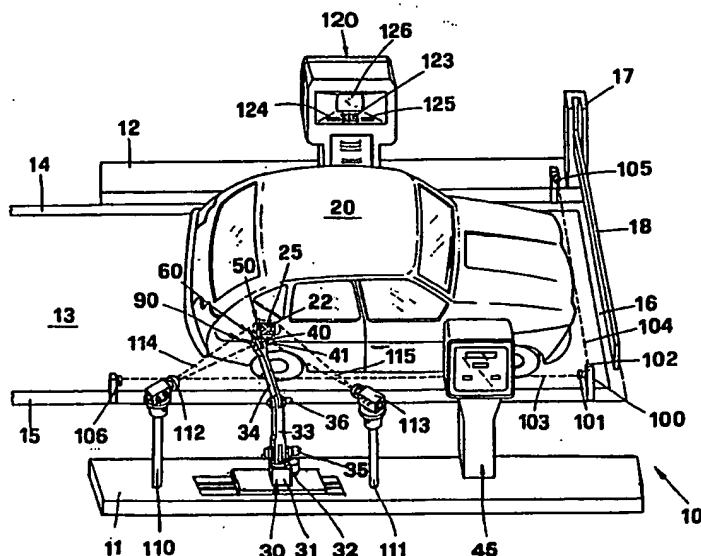




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(21) International Application Number:</b> PCT/IT93/00017 <b>(22) International Filing Date:</b> 26 February 1993 (26.02.93)  <b>(30) Priority data:</b> MI92A001898      31 July 1992 (31.07.92)      IT  <b>(71)(72) Applicants and Inventors:</b> BRAZZELLI, Gian, Carlo [IT/IT]; Via S. Francesco d'Assisi, 60, I-10068 Villafranca Piemonte (IT). BOSCO, Giammaria [IT/IT]; Via Polzano, 3, I-12030 Polonghera (IT). CAMPPIA, Valter [IT/IT]; Via S. Sebastiano, 17, I-14018 Roatto (IT). ARNONE, Paolo [IT/IT]; Viale Matteotti, 3, I-10048 Vinovo (IT). LEGA, Giovanni [IT/IT]; Via Caprilli, 43, I-20148 Milano (IT).		<b>(74) Agent:</b> DI GIOVANNI, Italo; Ufficio Brevetti Dott. Ing. Digiovanni Schmiedt, Via Aldrovandi, 7, I-20129 Milano (IT).  <b>(81) Designated States:</b> AT, AU, BB, BG, BR, CA, CH, CZ, DE, DK, ES, FI, GB, HU, JP, KP, KR, LK, LU, MG, MN, MW, NL, NO, NZ, PL, PT, RO, RU, SD, SE, SK, UA, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>

**(54) Title:** AUTOMATIC REFUELLING STATION**(57) Abstract**

Station (10) for refuelling motor vehicles (20) comprising a set of telecameras (112, 113) for reading the spatial positions of the door (22) and plug on the fuel tank of the motor vehicle (20), a robot (30) with three short arms (50, 60, 90) respectively for opening and closing the door (22), taking out and putting back the plug and for filling up with fuel, and a computer which, after the driver has inserted a magnetic card into the slit (124) made in a set of automatic controlling equipment (120) and has tapped on a keyboard (123) the quantity of fuel required, operates the robot (30) and then, when all phases have been concluded, raises an automatic barrier (18) placed across the exit from the filling station (10).

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#### AUTOMATIC REFUELLING STATION

The invention concerns pumps for distribution of fuel.

The refuelling of motor vehicles requires a series of somewhat time-consuming and complex operations especially today when more and more pumps have no personnel and drivers must put in fuel themselves.

If, however, service personnel is available, drivers of vehicles often have to get in line and patiently await their turn.

10 Where the pump is self-service, the driver must get into position, leave the vehicle, put sufficient bank notes into a pay box, then do all the other things with the vehicle and the pump which would otherwise be done for him.

15 Bearing in mind that, by their very nature, motor vehicles are synonymous with 'speed' and 'comfort', all these operations become burdensome emphasising their conflict with such characteristics.

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Purpose of the invention is to deprive filling stations of their present drawbacks by introducing efficient means that will drastically alleviate the difficulties connected with refuelling, as will be explained below.

5 Subject of the invention is a station for refuelling motor vehicles. The station comprises:

- a set of telecameras for ascertaining the spatial position of the door covering the plug closing the fuel tank;
- a robot for automatic operations such as opening the above
- 10 door, taking out the plug, putting fuel into the tank, replacing the plug and closing the door over it;
- a set of equipment placed at a height within easy reach of the seated driver; this includes a magnetic card reader, a keyboard on which the quantity of fuel or anything else
- 15 is tapped out, a receipt distributing device and a monitor for giving instructions to the driver and showing the operations that have been carried out;
- a computer for handling the sequence of operations.

When a motor vehicle stops at the station, the telecameras

20 check on the vehicle's position.

Following the instructions that appear on the monitor's screen, the driver inserts his card and presses the keys indicating how much fuel is needed.

The card is automatically returned with the sum deducted

25 for the quantity of fuel requested, and the printer issues a receipt which appears through a slit.

The computer then makes the robot carry out a sequence of movements for filling the vehicle's tank.

In a preferred type of execution the robot stands on a horizontally translating slide above which is an axially rotating vertical column, a vertical arm articulated onto

30

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said column, a horizontal arm articulated onto the vertical arm and a series of motors which, by translation of the slide, axial rotation of the column and rotation of the arms, cause the robot's operating head to assume a position that, in relation to the three spatial axes X,Y,Z, is virtually aligned with the door to the fuel tank on the vehicle standing at the filling station, and therefore aligned with the fuel tank's plug at a regular distance from it.

10 The robot's operating head carries three smaller arms, one for opening and closing the door over the plug, one for taking out the plug and putting it back, and the third for putting in the fuel.

The above smaller arms lie in three directions at equal angular distances one from another, while the head rotates centrally to permit one or other of said smaller arms to assume its operative position.

At the end of the first arm is a flexible suction device, preferably connected to a fan, so that when the arm comes in contact with said door over the tank, the suction device sticks to the door and pulls it open as said arm moves backwards, while the reverse can be done and the door closed again after filling.

The second of the smaller arms has a rod fixed, for rotation, to the shaft of a motor but free to move axially in relation to said shaft. Mounted on said rod is a tooth which touches a sensor connected to the computer.

Said shaft also carries means whose angular position is indicated to a second sensor also connected to the computer.

30 On the tip of the rod are means for penetrating inside a cavity, cut in the plug closing the vehicle's fuel tank,

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both in a longitudinal and an angular direction.

Therefore, as the arm reaches the plug, the means on said tip fit onto it.

Ascertainment of the rod's end-stroke position by the first  
5 sensor, makes the motor give the necessary rotating motion that unscrews the plug, which is then lifted off by the rod leaving entry to the fuel tank clear.

Reversing the operation, after refuelling, the plug is put back.

10 The third of the smaller arms ends in a tubular rod connected to the pipe of the fuel distribution pump.

On said rod is a sensor which, when it feels that the rod has been inserted into the tank mouth, permits fuel to pass through.

15 A solenoid valve connected to the computer controls the quantity of fuel to be put into the tank.

This operation having been completed, the filling arm is drawn back to allow the second and the first arms to repeat their operations in reverse.

20 When the vehicle stops at the filling station, a specially placed upright, carrying two orthogonal sensors, notes the position of the vehicle, sideways and longitudinally, and informs the driver, by emitting visual signals, if the vehicle's position is correct or not, intimating that the

25 filling sequence can commence only when the position is right. At the conclusion of the above operations, a barrier across the exit automatically rises to allow the vehicle to leave.

The positions of the filling door and of the fuel plug  
30 on the vehicle are indicated to the telecameras by reflectors and fluorescent paint.

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The advantages of the invention are evident.

The driver has simply to stop the vehicle in the right position facing the moveable barrier, put in his magnetic card and tap out his needs on the keyboard.

- 5 Subsequent operations are carried through swiftly and automatically.

At their conclusion the computer raises the barrier and the traveller can proceed, having stopped only long enough for execution of the above operations.

- 10 The driver's comfort is greatly increased while a similar advantage also accrues to the filling station manager who effectively exploits his installation, due to speedy refuelling of vehicles, and so recovers his investment and running costs within a short time.

- 15 Characteristics and purposes of the invention will be made still clearer by the following example of its execution illustrated by diagrammatically drawn figures.

Fig. 1 Automatic refuelling station, perspective view.

Fig. 2 Distributing robot, perspective view.

- 20 Fig. 3 Controlling equipment, perspective view.

Fig. 4 Operative distributing head in the position for opening the door over the tank plug of a motor vehicle, perspective view.

- 25 Fig. 5 Operative distributing head in the position for lifting out the tank plug of the vehicle, perspective view.

Fig. 6 Above operating head during the actual refuelling process, perspective view.

- 30 Fig. 7 Detail of the pincer means for detaching the plug, lateral cross section.

Fig. 8 Detail of the filling tube.

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Fig. 9 Diagram of layout of equipment for operating the refuelling station.

The station 10 comprises the robot 30 alongside the automatic fuel pump 45, both of which are installed on the raised footway 11 parallel to another raised footway 12 beyond the area 13 where the motor vehicle 20 will stop, said area being marked off by the longitudinal strips 14 and 15, and the front strip 16.

The controlling equipment 120 is installed on said raised footway 12 and at the inner end of said equipment stands the upright 17 supporting the stop barrier. 18.

Near the angle formed by strips 16 and 15 stands the upright 100 on which are two sensors at 90°, 101 and 102, for emission of beams 103 and 104, the first being alongside the longitudinal strip 15 and the second alongside the front strip 16, their purpose being to read the lateral and longitudinal positions of the motor vehicle. Columns 110 and 111 are installed one on each side of the robot 30, said columns supporting telecameras 112 and 113 respectively, the purpose of said telecameras being to read the spatial position of the fuel plug 80 on the motor vehicle 20.

The robot 30 is supported by the horizontally translating slide 31 and comprises the axially rotating column 32 which, by means of articulation 35, supports the vertical arm 33 and this in turn, by means of articulation 36, supports the horizontal arm 34 at whose end is mounted the distributing head 40 by means of articulation 41. Said head comprises the three smaller arms 50, 60, 90 placed at an equivalent angular distance  $\alpha$  one from the other. At its end arm 50 carries the suction means 51 articulated



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at 52 and connected to a fan by means of an elastic tube. Arm 60 terminates in a short rod 71 whose tip 61 will penetrate inside the seat 81 of the plug 80 closing the fuel tank of the motor vehicle 20.

- 5 Said rod 71 can slide axially in the arm 60 compressing the axial helical spring 62 and, by means of the disc 63, indicates its longitudinal axial position to the electronic sensor 64.

Said tip also rotates axially worked by a motor 65 through  
10 a shaft 72 and, by means of the device 66, indicates its angular position to the sensor 67.

The tip 61 of rod 71 carries the diametrically opposed teeth 69 and action by the internal spring 68 and the notches 70, keeps them at a short distance from said extremity.

- 15 The vehicle's tank plug 80 comprises the cover 82, the actual internal plug 83 and front cylindrical expansion 84 with teeth 86 lodged in the seats 85 open towards the axial cylindrical cavity 81 which also comprises the diametrical seats 87.

- 20 From the foregoing it will be seen that, using said arm 60, the robot can unscrew the plug 80.

For this purpose the arm 60 is brought axially close to the plug 80 so that the tip 61 enters the cavity 81 and the teeth 68 are held in the seats 87 in said cavity while  
25 the teeth 85 in said cavity are held in the seats 70 in the tip 61.

These positions having been acquired the sensor 64 sends out its signals for axial rotation of said tip to commence to the point where the tap 80 becomes unscrewed, signalled  
30 by the sensor 67.

The arm 60 then withdraws taking the plug with it and so

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leaves open the mouth 24 inside the cavity 23 over which the door 22 closes.

At this stage the head 40 of the robot 30 make a  $\propto$  angular turn so that arm 90 assumes the former position of arm 60.

5 The end 91 of this arm is tubular and along it slides the bushing 92, served by the helical spring 93, said bushing then touching the sensor 94 which permits fuel to flow in as soon as the bushing comes in contact with the opening 24 into the vehicle's tank, bringing into operation the  
10 solenoid valve 96.

Fuel flows in through the pipe 95.

The controlling equipment 120 has, at a height in its base 121 accessible to the driver's arm, an alcove 122 containing a keyboard 123, slit 124 for receiving the magnetic  
15 card, another slit 125 for emission of the receipt, and the monitor 126 for seeing stages of the operations.

Inside this set of equipment is the computer 127 and all the electric, electronic and mechanical accessories and devices needed for logical handling of the filling station.

20 Electric and electronic connections are summarised in the diagram in Fig. 9 giving the reference numbers of the various devices.

#### Operation

When a vehicle, such as an automobile 20, needs fuel, it  
25 stops in the area 13 of the station 10 between the longitudinal strips 14 and 15 and near the front strip 18.

Its correct position is checked by beams 103 and 104 from the sensors 101 and 102.

The correct or incorrect position is then signalled by  
30 suitable visual or acoustic means.

Having moved the car to the right position, the driver can

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slide his magnetic card into the slit 124, then, guided by instructions on the monitor, tap onto the keyboard 123 the quantity of fuel he requires.

The computer deducts from the driver's 'account', stored  
5 in the card, the corresponding amount after which the printer 128 prints the receipt which is issued through the slit 125.

The computer 127 then puts in hand the refuelling operations described as follows.

10 Through their beams 114 and 115, the telecameras 112 and 113 evaluate the exact position of the door 22 over the fuel tank's plug, aided by the reflectors 25, and the computer 127 then moves the slide 31, so that the operating head 40 of the robot 30 assumes the right position in re-  
15 lation to said door 22, simultaneously moving the robot's arm 34 into place.

The head 40, with the small arm 50 as illustrated in Fig. 4, advances towards the side 21 of the automobile 20 and the suction means 51, with suction created by means of  
20 the elastic tube 53, clings to the door 50 aided by the articulation 52.

The head then withdraws and the door opens as seen in Fig. 4 leaving free access to the chamber 23 and thus to the plug 80 that closes the tank's mouth 24.

25 Suction then ceases and the head 40 rotates replacing arm 50 by arm 60 which moves up, grips the plug 80 as already described and lifts it out as seen in Fig. 5.

The head 40 then makes a further rotation and replaces arm 60 with arm 90 (Fig. 6).

30 The end 91 enters the tank's mouth 24 and, through the pipe 95, supplies fuel to the tank of the automobile 20 as already described.

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Having terminated fuel supply, the head 40 moves backward and arms 60 and 50 respectively assume their positions for putting back the plug 80 and for closing the door 22.

The computer then causes the barrier 18 to be raised allowing the automobile to resume its journey.

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CLAIMS

1. Station (10) for refuelling motor vehicles (20) characterized in that it comprises a system of telecameras (112 113) for reading the spatial position of the door (22) over the plug (80) in the motor vehicle's fuel tank, a robot (30) for the various automatic operations, and therefore for opening said door (22) to lift out the plug (80) in order to put in fuel through the mouth (24) of the tank in the motor vehicle (20), screw in the plug (80) again and close the door (22), a set of controlling equipment (120) placed at a height suitable for working it by a seated driver, comprising a reader of magnetic cards, a keyboard (123) for tapping out the quantity of fuel, or anything else, that is required, a receipt issuing means, a monitor (126) on which the driver reads instructions and the stages of operations, a computer (127) for controlling said operations, so that when a motor vehicle (20) stops at the station (10), the telecameras (112 113) read the spatial position of said motor vehicle (20) and so that when the driver, following the instructions on the monitor (126) forming part of the controlling equipment (120) has pushed in the magnetic card and tapped on the keyboard (123) the quantity of fuel or anything else desired, and when the card, from which the amount to pay for the fuel has been deducted, has been returned and a printer (128) has issued a receipt through a slit (125), the computer (127) operates the robot (30) which then executes a sequence of operations necessary for refuelling the motor vehicle (20).
2. Station for refuelling motor vehicles as in claim 1, characterized in that the robot (30) stands on a horizontally translating slide (31) and has an axially rotating vertical

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column (32), a vertical arm (33) articulated on the column (32), a horizontal arm (34) articulated on the first arm (33), an operating head (40) articulated on the second arm (34) and a set of motors that cause said head (40),  
5 following translation of the slide (31), axial rotation of the column (32) and rotation of the arms (33 34), to take up a position virtually aligned, in relation to the three spatial axes X Y Z, with the door (22) over the fuel tank of the vehicle (20) standing at the station(10),  
10 and therefore aligned with the tank's plug (80) and at a regular distance from said plug (80).

3. Station for refuelling motor vehicles as in claim 1, characterized in that the robot carries an operative head (40) having three short arms (50 60 90), one (50) for  
15 opening and closing the door (22), another (60) for taking out and replacing the plug (80) and the third (90) for filling the tank with fuel, said short arms (50 60 90) being disposed in three directions at an equal angular distance one from another, said head (40) rotating at the centre of  
20 the three arms to allow one or other (50 60 90) to assume its operative position.

4. Station for refuelling motor vehicles as in claim 3, characterized in that at the end of the first short arm (50) there is a flexible suction device (51), preferably connected to a fan, so that when said arm (50) comes in contact  
25 with the door (22) over the fuel tank of the vehicle (20), the suction device (51) can pull it open as the arm (50) withdraws, while by conducting a reverse operation, the door (22) can be closed after filling has been completed.

30 5. Station for refuelling motor vehicles as in claim 3, characterized in that the second short arm (60) comprises

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a rod (71) free to move axially in relation to the shaft (72) of a motor (65), there being fixed to said rod (71) a tooth (63) that makes contact with a sensor (67) connected to the computer (127), there being fixed to said shaft (72) means for indicating its angular position to a second sensor (64) connected to the computer (127), there being at the tip (61) of the rod (71) means that will fit inside a cavity (81) in the plug (80), both in a longitudinal and in an angular direction, so that when the arm (60) approaches said plug (80) the tip (61) makes connection with it, the first sensor (64) permits rotation of the motor (65) thus unscrewing the plug (80) which is then removed by the rod (71) leaving free the opening (24) in the fuel tank of the vehicle (20), while by reversing the operation the plug (80) can be replaced once the fuel has been put in.

6. Station for refuelling motor vehicles as in claim 3, characterized in that the third short arm (90) ends in a tubular rod (91) connected to the fuel pipe of the pump, provided with a sensor (94) which, warned by an elastic contacting means (92) that said rod (91) has been duly inserted into the fuel tank's mouth (24) on the vehicle (20), permits fuel to pass through, a solenoid valve (96) worked by the computer (127) then controlling the quantity of fuel to go in while, this having been done, the arm (90) withdraws enabling the second arm (60) and then the first arm (50) to return to their respective operative positions.

7. Station for refuelling motor vehicles as in claim 1, characterized in that a specially placed upright with two orthogonal sensors (101 102) reads the lateral and longitudinal positions of the motor vehicle (20) and warns the driver, by suitable acoustic or visual means, whether or

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not the position of the vehicle is correct and only permitting the sequence of operations to commence when the right position has been reached.

8. Station for refuelling motor vehicles as in claim 1,  
5 characterized in that an automatic barrier (18) is placed across the exit from the station (10) and this rises to clear the way out when the various operations have been concluded.

9. Station for refuelling motor vehicles as in claim 1,  
10 characterized in that the position of the door (22) and of the plug (80) in the vehicle's fuel tank are signalled to the telecameras (112, 113) by the presence of reflectors (25) and fluorescent paint.



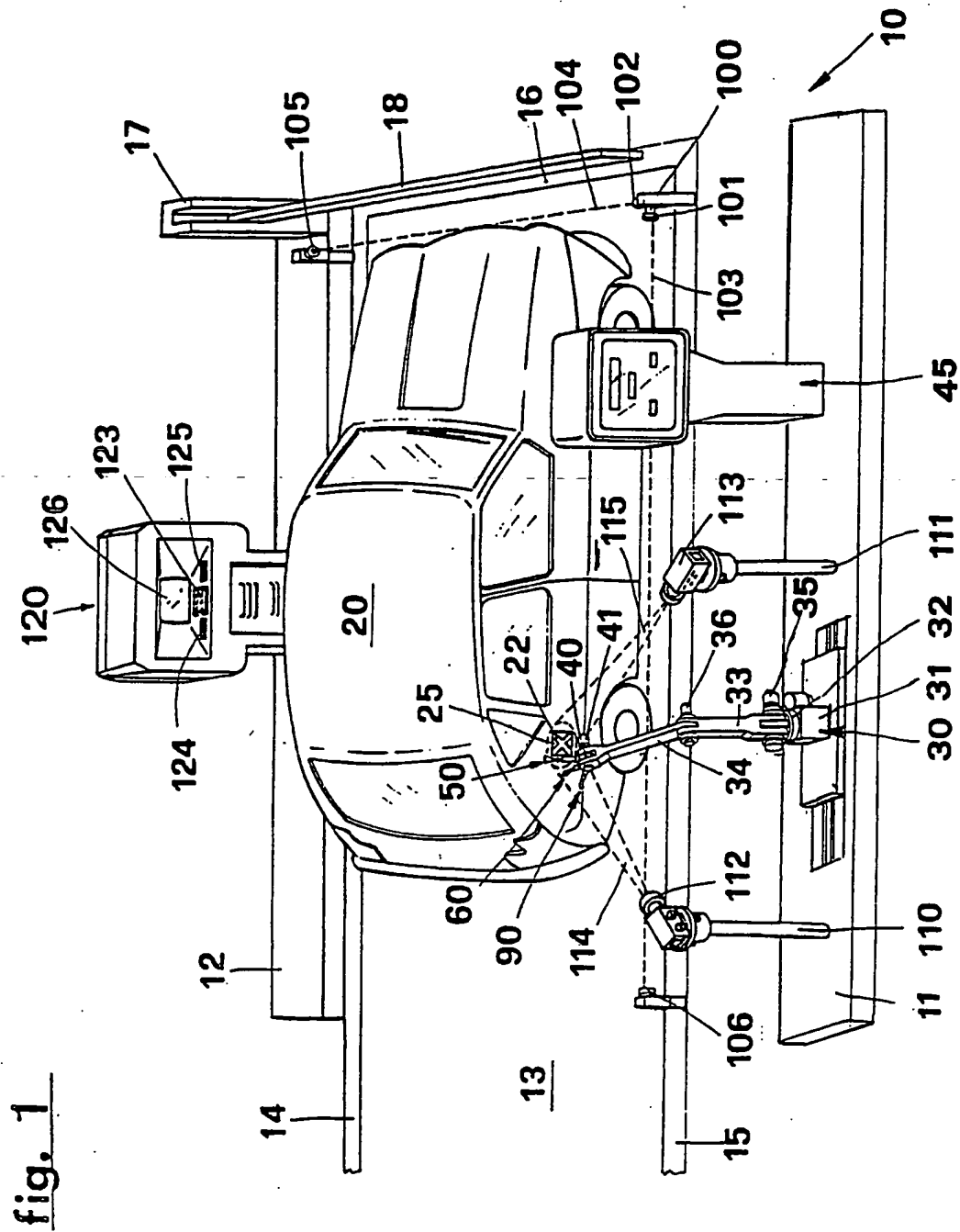
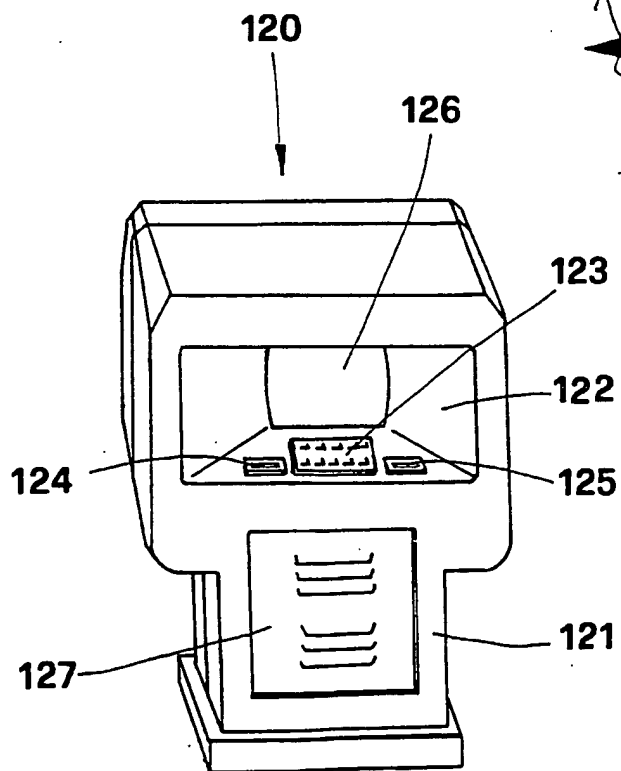
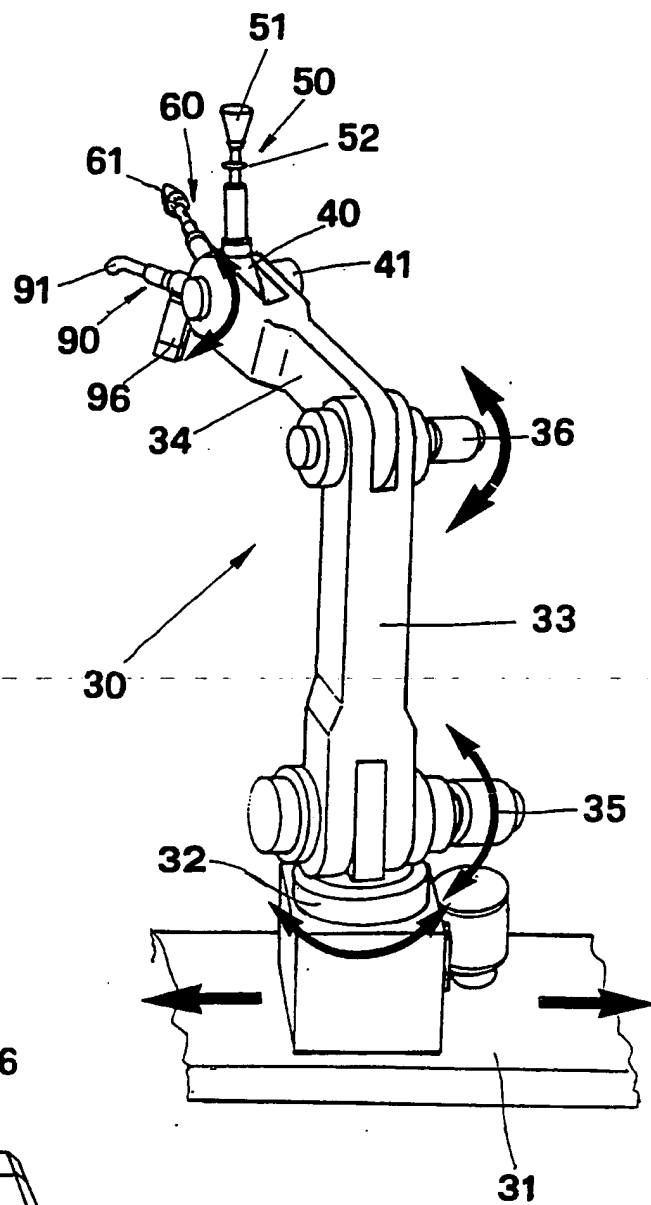
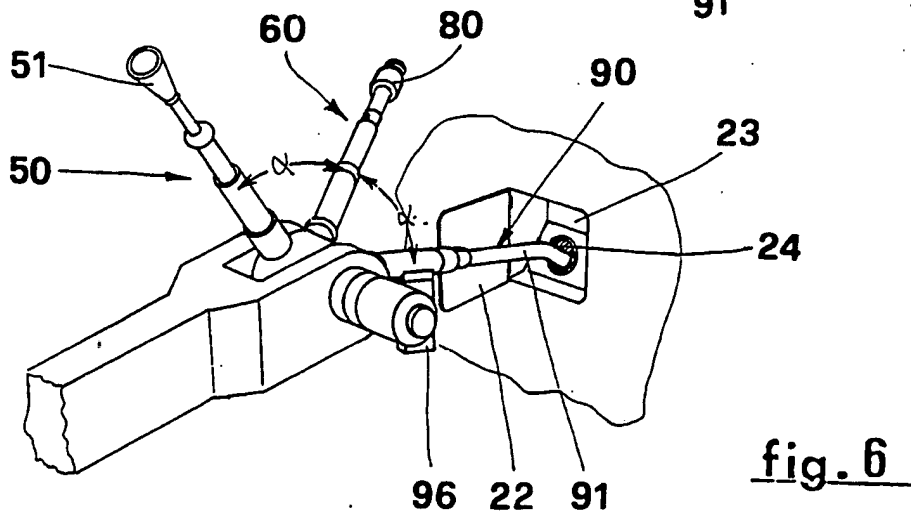
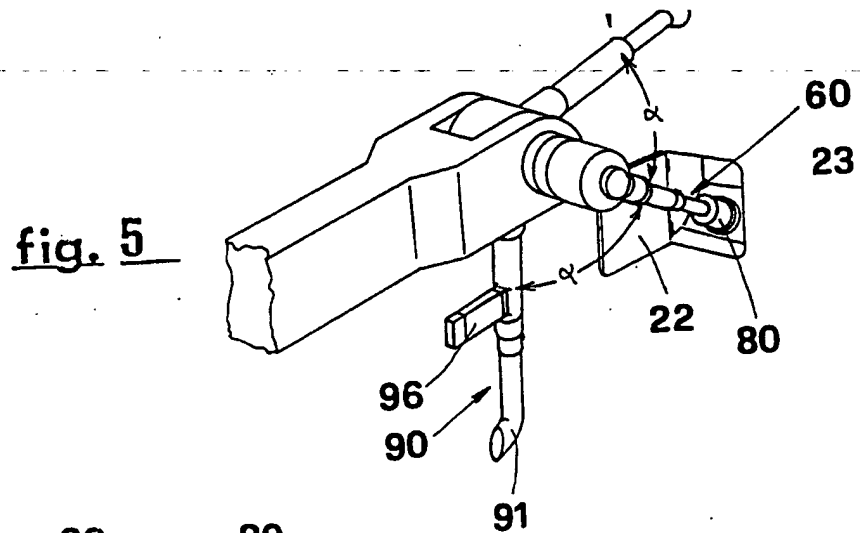
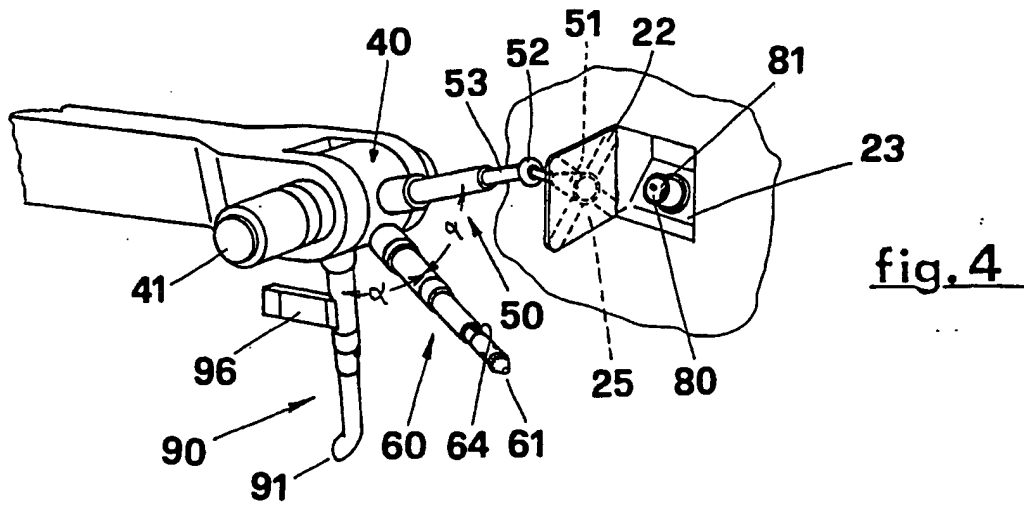


fig. 2fig. 3



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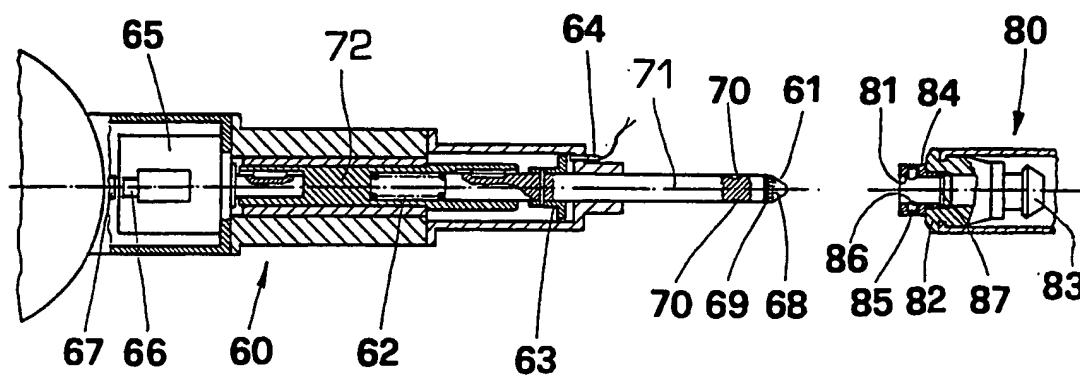


fig. 7

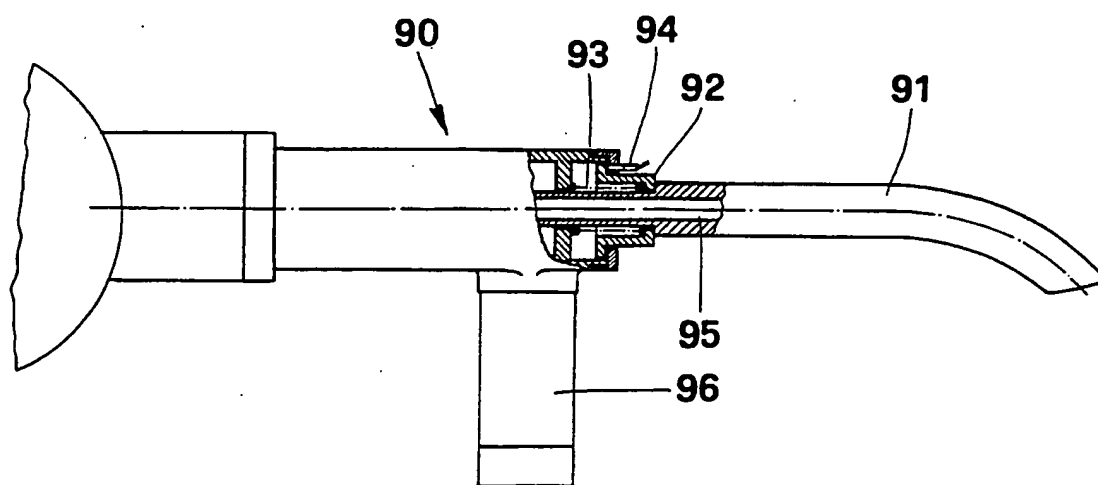


fig. 8

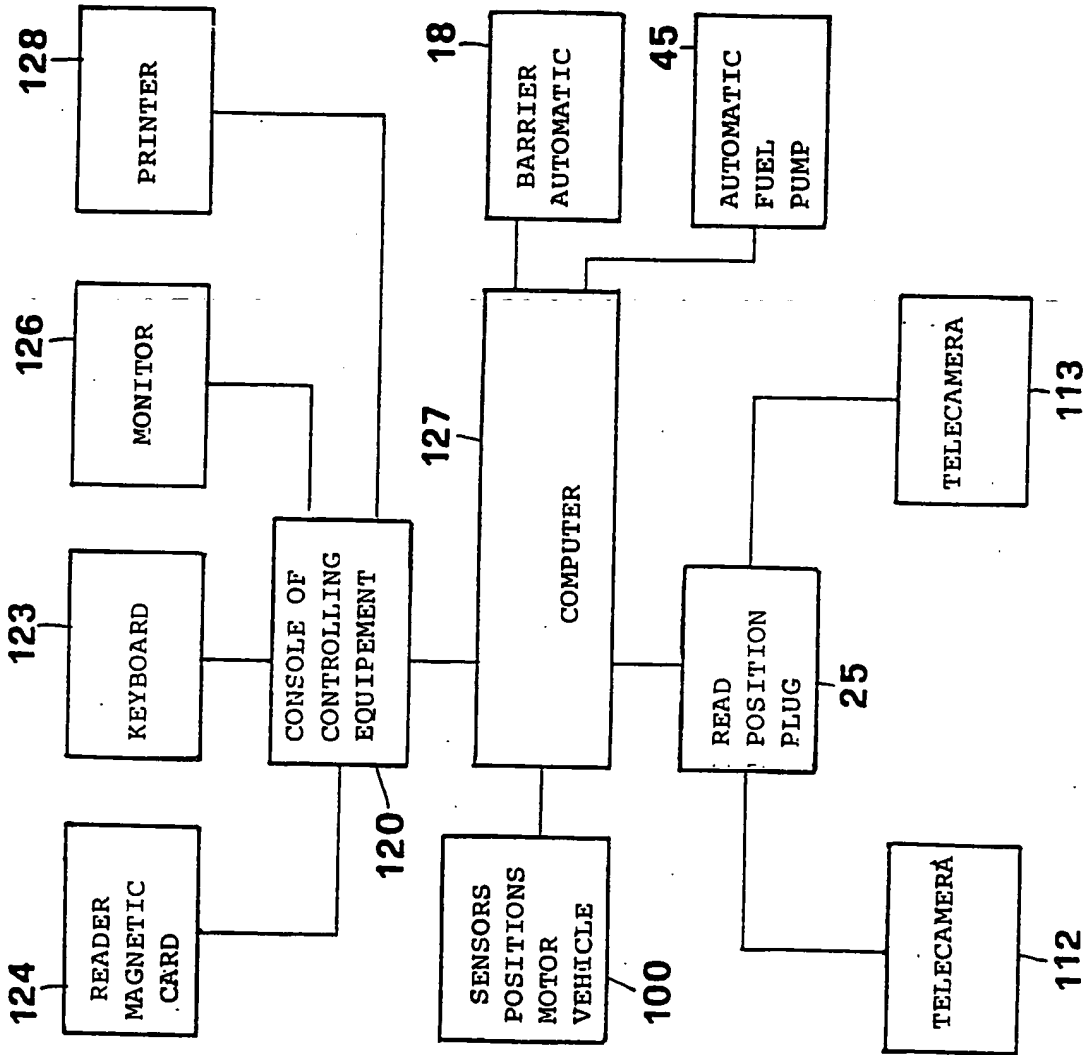


fig. 9

## INTERNATIONAL SEARCH REPORT

PCT/IT 93/00017

International Application No

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5 B67D5/08; B67D5/14		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	B67D	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
Y	US,A,3 527 268 (I. GINSBURGH) 8 September 1970 see the whole document ---	1-9
Y	EP,A,0 418 744 (ETS ELEKTRONIK GMBH BERATUNG+VERTRIEB) 27 March 1991 see column 10, line 23 - column 12, line 40 see column 13, line 13 - line 51 see column 14, line 33 - line 53; figures 1-10 ---	1-9
A	PATENT ABSTRACTS OF JAPAN vol. 16, no. 248 (M-1261) 5 June 1992 & JP,A,40 57 789 ( TOKICO LTD ) 25 February 1992 see abstract --- -/--	1-3,7,9
<p><sup>10</sup> Special categories of cited documents :          "A" document defining the general state of the art which is not considered to be of particular relevance          "E" earlier document but published on or after the international filing date          "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)          "O" document referring to an oral disclosure, use, exhibition or other means          "P" document published prior to the international filing date but later than the priority date claimed</p> <p>"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention          "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step          "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.          "&amp;" document member of the same patent family</p>		
<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search 04 JUNE 1993		Date of Mailing of this International Search Report 7 4. 06.93
International Searching Authority EUROPEAN PATENT OFFICE		Signature of Authorized Officer LILIMPAKIS E.

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
Category °	Citation of Document, with indication, where appropriate, of the relevant passages	Relevant to Claim No.
A	US,A,4 881 581 (J.A. HOLLERBACK) 21 November 1989 see column 3, line 13 - column 4, line 62 -----	1-3,7,9

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO.**

IT 9300017  
SA 70736

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-3527268	08-09-70	None	
EP-A-0418744	27-03-91	DE-A- 3930981	28-03-91
US-A-4881581	21-11-89	None	



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